ACTIVITY BUMPER PACK

This bumper pack contains 15 hands on activities for you to get involved this STEPS Engineers Week. You can carry out one or as many activities you like! Print and copy the activity page of your choice.

Contents

APPLE MUMMY

Salt has been used as a preservative since ancient times, to protect food against bacteria, mould, and spoiling. Have you ever noticed that you get thirsty when you eat salty food? Well, this is because salt is a desiccant - it helps remove water from things, including human bodies.

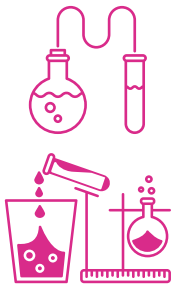
A mummy is the body of a person (or an animal) that has been preserved after death. The Ancient Egyptians used desiccants when they were mummifying bodies. Baking soda and salt are desiccants we're going to use to mummify an apple!

ENGINEERING CONNECTION

Chemical engineers examine chemicals like desiccants to understand how they interact with food and bacteria. Using concepts of preservation, engineers are able to provide new techniques to preserve and protect foods.

WHAT YOU WILL NEED

- A knife
- 2 plastic cups
- 1 apple
- 40 grams of baking soda
- 80 grams of table salt



HOW YOU CAN DO THIS

1. Cut the apple into quarters so that you have four similar size pieces.
2. Place two pieces in each cup.
3. Mix the baking soda and salt and add it to one of the cups. Make sure the apple is completely covered with the mixture.
4. Place the cups somewhere out of direct sunlight and let them rest for a week.
5. After a week, carefully pour the mixture out of the cup with the covered apple. Do not wash it. Compare the two halves. Which is better preserved?

WHAT ACTUALLY HAPPENED

You will notice that the apple with baking soda and salt has shriveled up – it has been preserved by the mixture. The other cup contains a rotting apple. Bacteria that cause rotting and decay need water to survive. By drying out the apple with desiccants, we make it difficult for bacteria to grow.

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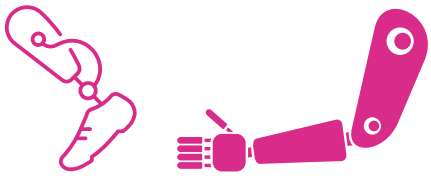
ARTIFICIAL LIMB

ENGINEERING CONNECTION

Biomedical engineers use this concept to recreate various parts of the human body.



WHAT YOU WILL NEED

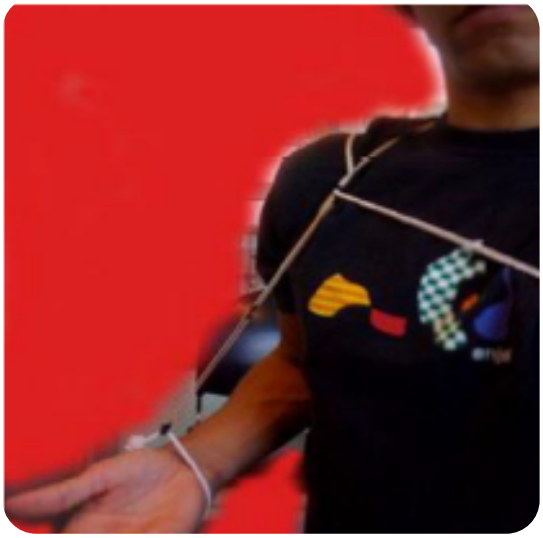
- **Rubber bands. A variety of sizes are needed.**
- **Thin rope 2.5m in length**
- **String 0.5m in length**
- **Scissors**
- **A sheet of paper**

HOW YOU CAN DO THIS

1. Outline the challenge for the class. To create a device to assist with the recovery of the bicep, allowing it to rest more and therefore recover sooner.
2. Outline the materials available to the class.
3. Suggest that the design should include a hand and shoulder harness made from the rope connected with pieces of string that are tied to rubber bands.
4. See the What Actually Happens section below for examples and tips.

WHAT ACTUALLY HAPPENS

- As shoulder harness might have two loops of rope connected, llike a figure of eight, so that one goes around the arm and the other goes around the chest.
- A hand harness might also be created from rope made into a figure of eight with one loop going around the middle finger and other going around the wrist.
- Use the rubber bands to connect the shoulder harness to the wrist so that they pull on the arm when it is straight.



BLASTING BALLOONS

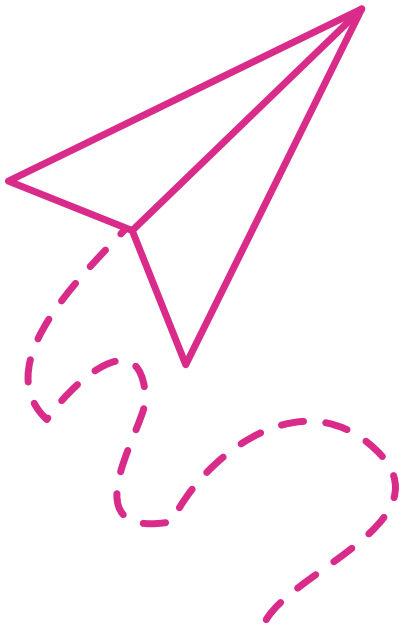
WHAT YOU WILL NEED

- **All you need is a balloon that has been inflated**

HOW YOU CAN DO THIS

1. The aim is to try and hit the balloon as far as you can through the air, using only your hands.
2. Hit the balloon lightly first. Take a few recordings of how far it travels.
3. Hit the balloon harder after this. You should find that its path is unpredictable, and it doesn't necessarily travel further than when you tipped the balloon lightly. Indeed, when hitting the balloon hard, it initially goes fast, but its path is unpredictable and it will slow down rapidly.

WHAT ACTUALLY HAPPENS



- An aeronautical engineer deals with situations like this. They will tell you that the reason the balloon which is hit more vigorously will not travel as far is because of drag with the air surrounding it. When the balloon is hit gently, it doesn't affect the air around it as much as when it is hit harder.

- The harder you hit the balloon, the more you will accelerate the air around it. This is why the balloon why move at a quick rate. However, friction between the air and the balloon means that the balloon will slow down. The air surrounding it will lose its speed at a slower rate, and will move past the balloon.

- As the surrounding air passes the balloon, the circular currents of air can act against it, causing the sudden change in the direction. This is why the balloon will generally go further if you hit it gently as opposed to vigorously.

MENTOS AND DIET COKE

WHAT YOU WILL NEED

- **A packet of Mentos mints**
- **Two litre bottle of a fizzy beverage. Something like a diet cola is ideal, as it will produce a spectacular result, but everything won't be as sticky afterwards!**
- **A small piece of paper can also be handy to use.**

HOW YOU CAN DO THIS

1. Take the minds out of the packet, and drop them all into the diet drink at the same time.
2. This can be difficult, so you might roll the piece of paper into a tube that can just about hold the sweets, and use this to drop them in.
3. This should result in an eruption of the drink, and is why we needed the space around the bottle!

WHAT ACTUALLY HAPPENS

The reason for this reaction can be explained using chemistry, the type of science of science vital to chemical engineering. As we know, the drink we used was fizzy. This process of making a drink this way is called carbonation, and involves using high pressure to force Carbon Dioxide into the bottle containing the beverage. The pressure is so high, that the Carbon Dioxide gas can't form into bubbles, but instead is dispersed throughout the liquid and becomes invisible. The Carbon Dioxide gets trapped in the water molecules in the liquid, and can only escape when the tension of the water holding the gas is broken, and a bubble is allowed to form.

Each Mentor sweet has ingredients that help break this tension, and thus bubbles are easily formed. When many bubbles form, they will all try to try to the surface. The fact that each mint will sink to the bottom of the bottle means that a larger part of the liquid will be affected, and also as the bottle narrows near the top, the bubbles have to all try to escape through a small gap at once. This results in the spectacular explosion,

PEEL A RAW EGG

WHAT YOU WILL NEED

- **Clear vinegar**
- **Raw egg**
- **Glass jar with a lid (1/2 litre)**

HOW YOU CAN DO THIS

1. Fill up to half of the jar with the clear vinegar.
2. Place the raw egg inside the jar making sure the egg doesn't crack.
3. Tighten the lid on the jar.
4. Rest the jar safely on a shelf for about 36-48 hours. Do not shake or move the jar.

WHAT ACTUALLY HAPPENS

The shells are made of calcium carbonate (ask your parent/guardian to use them for garderning, they are good for plants), while the vinegar is an acid.

We know that acids react with alkalines (which in the case is the egg shell) to produce salt and carbon dioxide. You will notice carbon dioxide bubble forming right after you place the egg in the vinegar. This reaction then dissolves all of the egg shell over the next 48 hours and leaves behind a see-though membrane keeping the egg together.
After the wait is over you can take the egg out and do fun stuff with it. Maybe draw a smiley face on it?

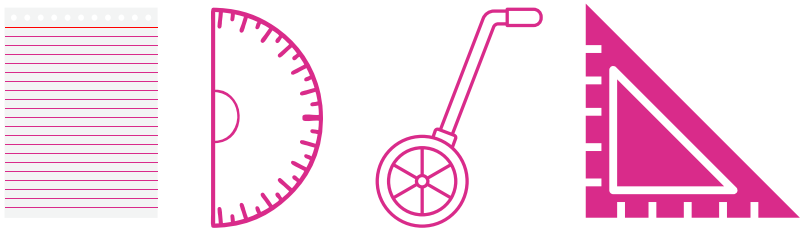
Remember: The membrane an egg has is very fragile, be careful not to break it.

We"ll never know which ingenious chemical engineer came up with this experiment!

POTATO ARCH

WHAT YOU WILL NEED

- **An A4 sheet of paper**
- **A measuring device such a trundle wheel, set squares and protractors.**



HOW YOU CAN DO THIS

1. We are aiming to make an arch, so we need pieces that taper in order to have them wider at the top than the bottom. Use the knife to make pieces that should be 12-15mm square, and with edges as straight as possible, apart from the slight taper we need to make a semi-circle shape for the arch. This is when the set square proves useful.
2. Using trial and error make an arch using the pieces you have cut.
3. If your arch is unstable, try and make the pieces thicker. If this doesn't work, make sure your arch isn't too high, and roughly follows the shape of the centenary curve (the curve a free hanging rope or chain makes).
4. You could try and investigate the mechanics of the arch by applying additional forces with you finger on variou parts of it. You could also raise the arch on two high and narrow supports, which should give you an insight as to why buttresses are used to help support them.

WHAT ACTUALLY HAPPENS

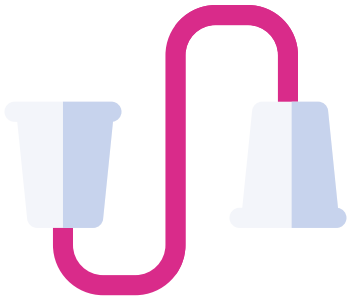
The arch is made up of blocks, and will stand with nothing attaching them together. The central block stays because it is wider at the top than the bottom, so to fall down it would have to push the neighbouring blocks outwards, as long as these are held securely the central block can't fall down.

This is the concept that was used by early civil engineers to make the bridges, some of which still exist today.

STRING TELEPHONE

WHAT YOU WILL NEED

- **Paper or plastic cups - 2**
- **String - 2 metres**
- **Scissors**
- **Pushpin - 1**
- **Paperclips - 2**

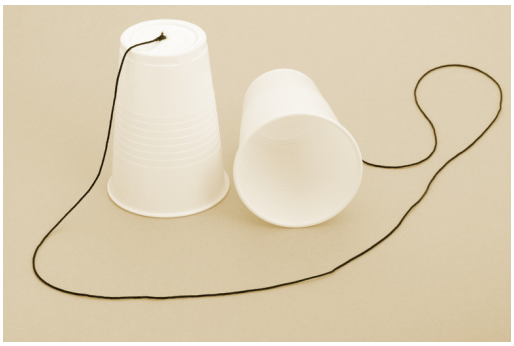


HOW YOU CAN DO THIS

1. Make a small hole on the bottom of each cup with the pushpin.
2. Thread the string through the hole and tie a paperclip to it to secure it.
3. Give one cup to a friend and take the cups far apart, so that the string is tight.
4. Listen and talk to each other standing at either end of your string telephone.

WHAT ACTUALLY HAPPENS

When you talk into the cup, that sound causes the cup to vibrate. This vibration is then transferred onto the string. This in turn causes vibration on the cup at the other end of the string. This vibration is transferred to sound which you hear.



Make sure the string is held tight and steady!

This can be your new 'walkie talkie'.

This can be an ideal experiment to explore what an electrical engineer does.

TOWER CRANE

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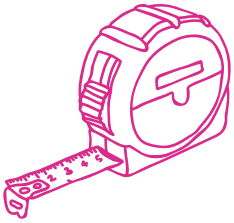
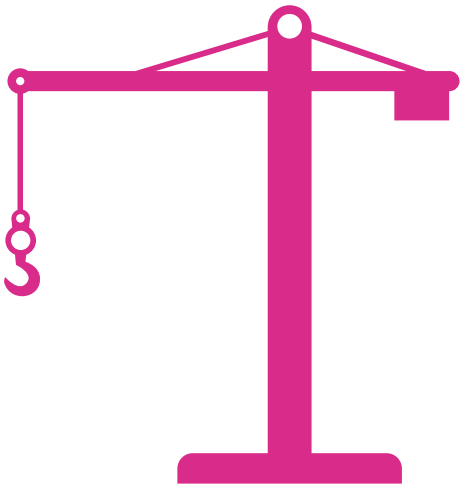
WHAT YOU WILL NEED

- **Thick string**
- **Scissors**
- **Masking tape**
- **Interior doorway**
- **Measuring tape**
- **Two small magnets**
- **Small metal objects like nails**
- **Shoebox**



HOW YOU CAN DO THIS

1. Using a measuring tape, cut out 13cm of masking tape.
2. Cut out another piece of masking tape of 8cm.
3. Stick the sticky side of the tapes together, leaving 2.5cm on either side.
4. Press the sticky ends of the tape horizontally across the top of the doorway, creating your pulley.
5. Measure the distance from the doorway to the floor. Double the number and subtract 60cm from it. Cut a long piece of string of the resulting length.
6. Pull one end of the string through the middle channel of the pulley and bring to the string to meet ground level.
7. Attach the pieces of the magnet together with the end of the string between them.
8. Spread the pieces of metal on the floor in the range of the string.
9. Use the free end of the strind to make the pulley work, and pick up the objects on the floor and collect them in the shoebox.



Mechanical engineers design cranes with great details to lift various things on a site.

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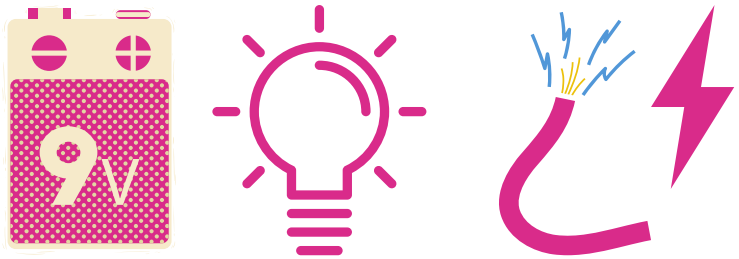
SIMPLE CIRCUIT

WHAT YOU WILL NEED

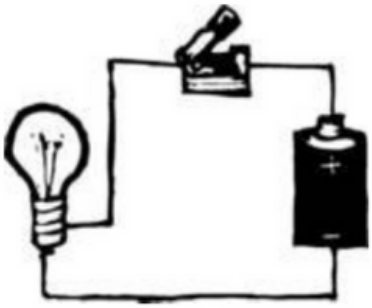
- **Red + Black wire - 30cm**
- **Scissors**
- **Bulb -1**
- **Bulb holder - 1**
- **9V battery - 1**
- **9V battery holder - 1**



HOW YOU CAN DO THIS

1. Cut the ends of the red and black wire with scissors.
2. Now, attach the end of the red and the black wire to the bulb holder.
3. Attach the other ends of the wire to either ends of the batter holder. Remember - Rid wire to the positive end, and black wire to the negative.
4. Now add the battery to the battery holder and screw in the bulb into its holder.

And there you have it! Your simple circuit with a bulb is now ready. You can try the same experiment with buzzers.



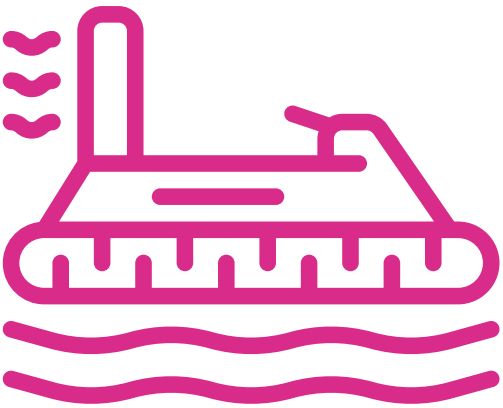
CD HOVERCRAFT

WHAT YOU WILL NEED

- **An old CD**
- **A balloon**
- **Adhesive tape**
- **A piece of card**
- **A biro lid**

HOW YOU CAN DO THIS

1. Make a cone shape with the card. The biro should be flush with the top of the cone when placed inside, and the bottom of the cone should be slightly larger than the hole in the centre of the CD.
2. Place the CD with the shiny side facing upwards. Try to form an airtight seal between the bottom of the cone and the hole in the centre of the CD.
3. Without covering the hole in the biro lid, affix it in the top of the cone.
4. Fix the balloon over the top of the cone, and make sure it stays in place.
5. You should be able to blow up the balloon through the CD. If you place the CD on a hard, flat surface it should more around with very little friction as a hovercraft would, until the air runs out of the balloon.



DETECTING AIR POLLUTION

WHAT YOU WILL NEED

- **A sheet of card/cardboard (around 10cm by 15cm)**
- **Clear adhesive tape (the wider the tape the better)**
- **One pair of scissors**
- **A piece of string, around 20cm long**
- **A (single) hold puncher**
- **If available, a microscope or magnifying glass**

HOW YOU CAN DO THIS

1. Cut a hole in the card. It can be any shape as long as it is 5cm by 5cm if square, or 5cm radius if a circle.
2. Punch a hole in the card near one end.
3. Make a loop through the punched hole with the string. The pollution detector should hang freely from the string.
4. Place the adhesive tape over the larger hole that was cut with the scissors. This will collect the airborne particles, so make sure it's clean and free from contact with clothes, skin etc.
5. Place pollution detectors in areas of interest, making sure the adhesive tape is exposed. They should be left in place for at least a day, but a weekend is optimum.
6. You might be interested in the difference between places such as an air conditioned office and beside a busy road.
7. After you collect the detector, you can use a microscope or magnifying glass to closely inspect and try to identify the particles. If these are unavailable, you should still be able to contrast the difference by eye.

BLOWING OUT CANDLES

The Coanda Effect is the tendency of a stream of fluid to stay close to a smooth surface it is flowing past, rather than follow a straight line in its original direction. Sometimes when you try to pour water from a jug the water runs down the side of the jug. This is the Coanda Effect. You also see the effect if you hold a spoon under a stream of water. The moving water will try to follow the lines of the surface, even if it has to change direction to do so. All liquids and gases behave this way

ENGINEERING CONNECTION

Engineers use the Coanda effect in hydropower stations to prevent fish from entering turbines.
Water containing fish and debris pass over a Coanda screen (a large curved sieve) and particle free water is collected below to power the turbines.
When designing airplane engineers need to be aware of the Coanda and use it in many of their calculations involving air flow.

WHAT YOU WILL NEED

- A candle
- A round bottle
- A small box
- A lighter/match etc.

HOW YOU CAN DO THIS

1. Light the candle and place the round bottle in front of the flame.
2. Try to blow it out from behind the bottle.
3. Light the flame again and hold the box in front of the flame, the same distance as you held the bottle.
4. Try to blow out the flame from behind the box.

If your demonstration doesn't work too well, try and vary the distance you place the candle from the object in front of it. They should be around 5cm apart.

WHAT ACTUALLY HAPPENED

You will notice that the apple with baking soda and salt has shriveled up – it has been preserved by the mixture. The other cup contains a rotting apple. Bacteria that cause rotting and decay need water to survive. By drying out the apple with desiccants, we make it difficult for bacteria to grow.

EGG DROP CHALLENGE

CAN YOU DESIGN A SYSTEM TO PROTECT AN EGG FROM CRACKING OR BREAKING FROM A HIGH FALL?

THE CHALLENGE

1. Gather the materials to help you design contraptions that will protect an egg from a fall.
2. Design and make contraptions to protect your raw egg.
3. Record your predictions in the printable recording sheet.
4. Discuss why certain contraptions work and others don't.

WHAT YOU WILL NEED

Raw eggs - Straws - Paper towels - Tape - Cardboard tubes - Paper - Cereal boxes

USE ANYTHING YOU'D LIKE!

ILLUSTRATE YOUR DESIGN IN THE BOX BELOW

Explain why you think your design will protect an egg from a fall.

EGG DROP CHALLENGE

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ASK

What's the challenge?
How can you solve it?

IMAGINE

What are some solutions?
Brainstorm ideas with your team

PLAN AND CREATE

Make a drawing.
Use your plan to test your ideas with your team

IMPROVE

Think about what could work better.
Modify your design and try again!

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EGG DROP CHALLENGE

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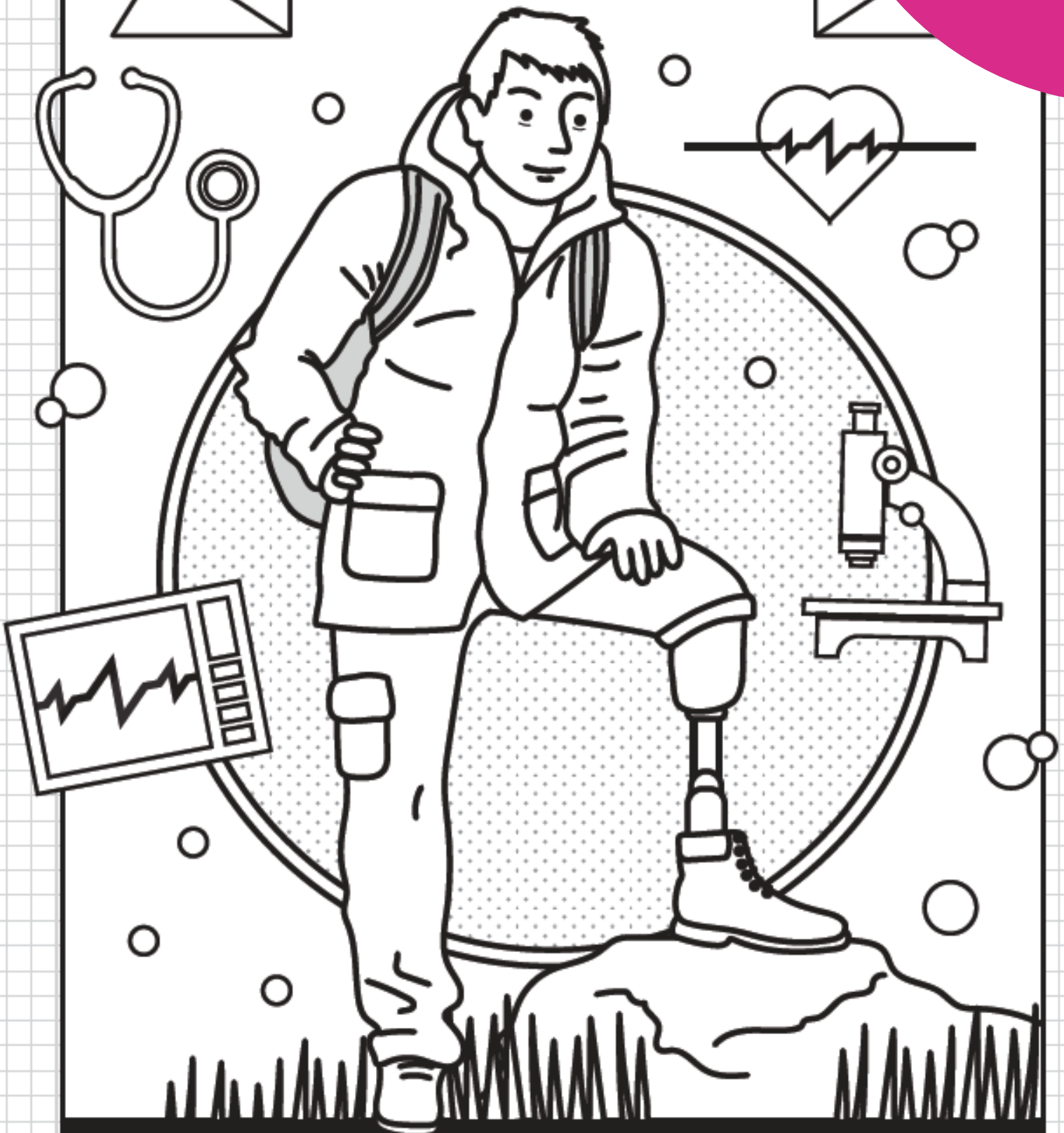
RECORDING SHEET

Egg drop contraption	Will this contraption protect the egg?	Why or why not?	Was your prediction correct?

BIOMEDICAL ENGINEERING



Biomedical engineers develop technologies and equipment to help save people's lives and improve their health.

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CHEMICAL & PROCESS ENGINEERING

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Chemical engineers develop the industrial processes used to make everyday products such as food, drink, drugs, cosmetics, plastics and electronics.

CIVIL ENGINEERING

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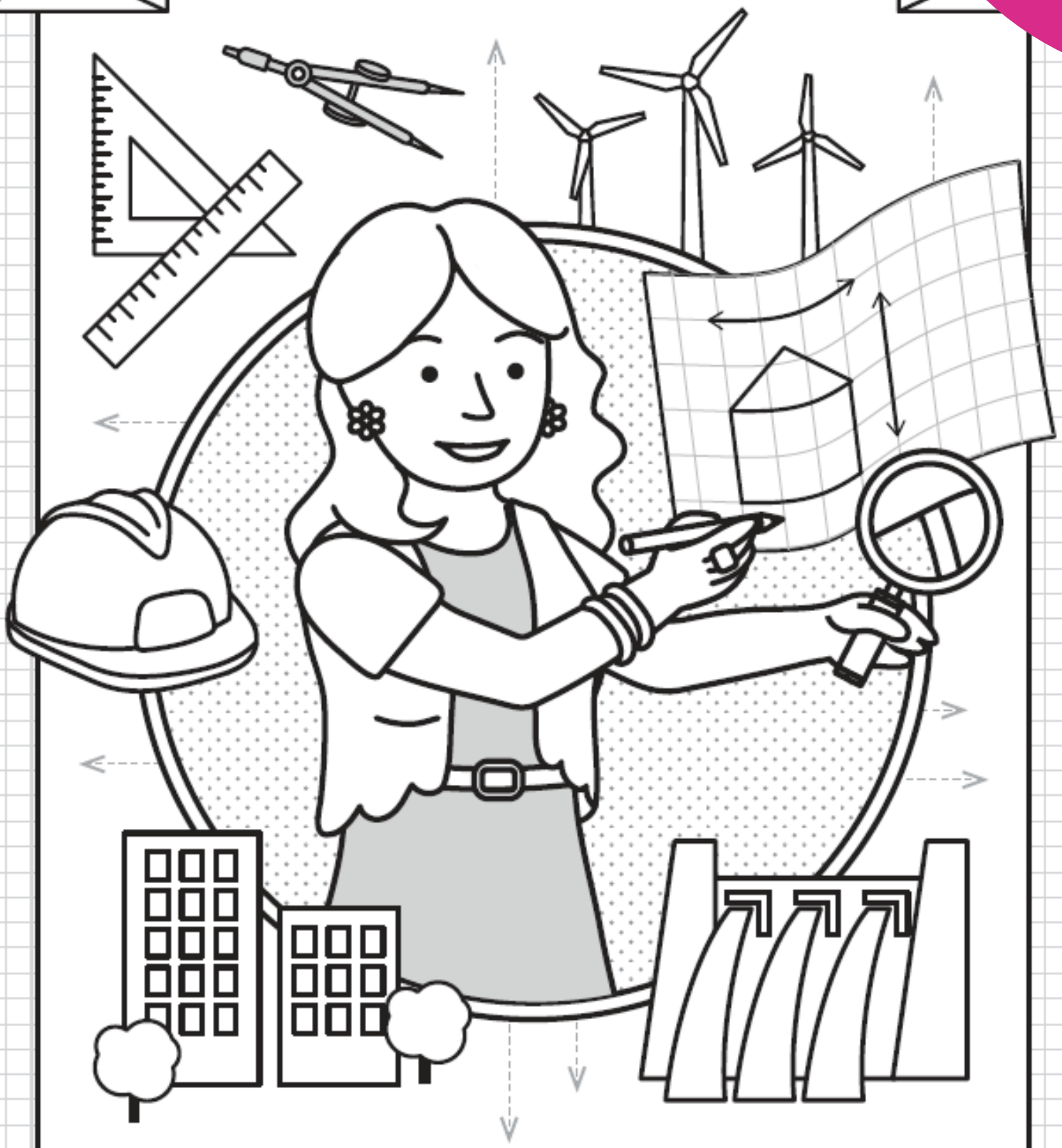

Civil, structural and environmental engineers design and construct the buildings and infrastructure that are essential to our modern society.

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COMPUTER & SOFTWARE ENGINEERING

Computer and software engineers design and develop hardware, software and information systems for computers and mobile devices.

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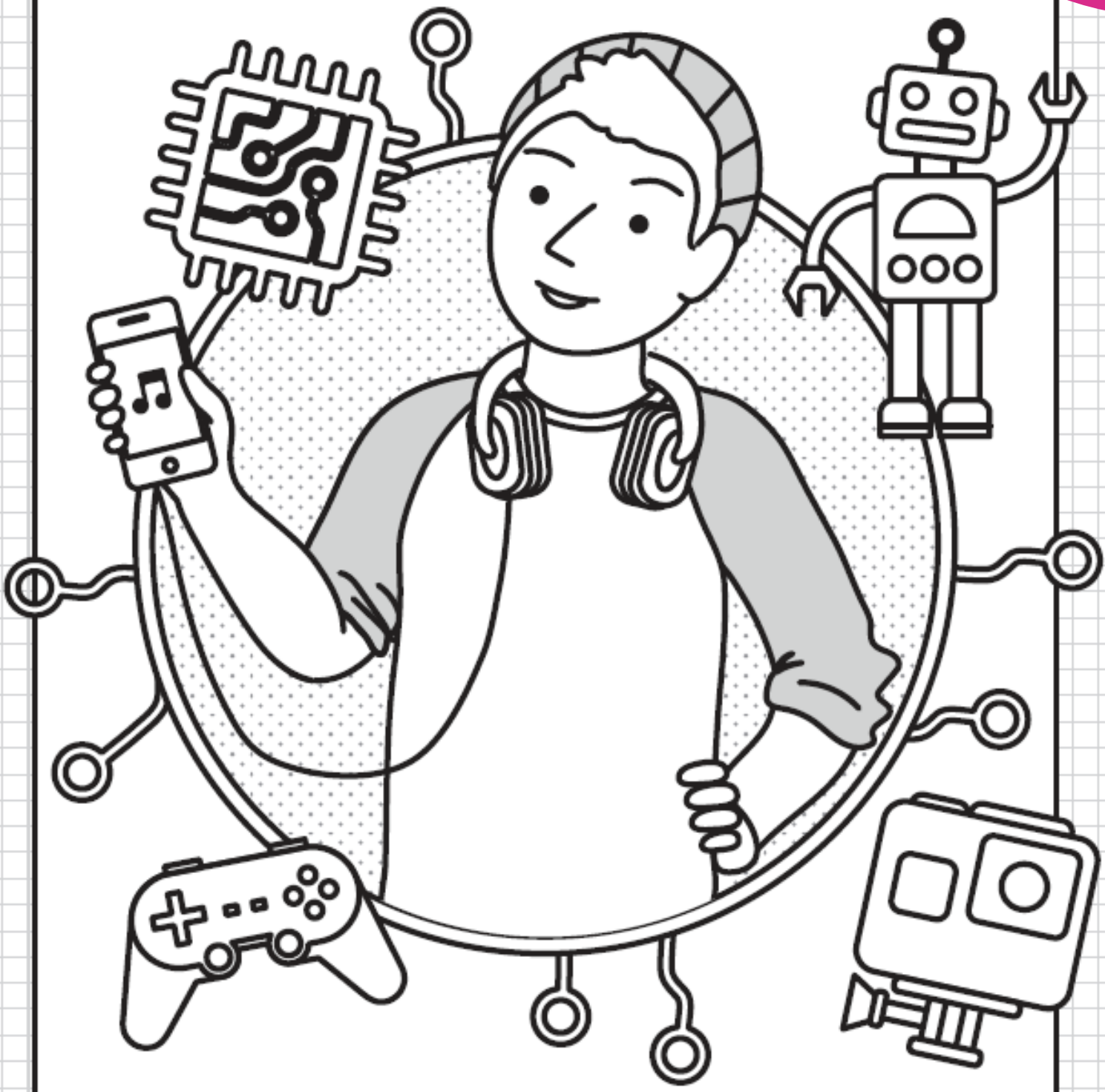
ELECTRONIC ENGINEERING



Electronic engineers design and develop the electrical and electronic equipment that we use every day, from mobile phones to microwaves.

BENDING WATER

Electricity is a type of energy that can come in many different forms. The two basic forms of electricity are static and current. When electricity gathers in one place it is known as static electricity; electricity that moves from one place to another is called current electricity.

Static electricity is the result of an imbalance between negative and positive charges in an object. It can be generated when you rub things together. When two objects rub against each other they can transfer electrons (negative charges) from one to the other causing one object to become positively charged and the other to become negatively charged.

Water is made up of charged particles and the charge can move about freely when water is in its liquid form. The flow of water can easily be affected by a static charge and we can use a few simple items to bend water using static electricity!

ENGINEERING CONNECTION

Electrical engineers work on a variety of projects, from tiny microchips to huge power grids that light up cities. When designing devices and projects, electrical engineers must understand the electrical properties of materials in order to choose the best materials. Many circuit-board components are sensitive to static electricity may become inoperable if too much static electricity is present. Engineers must consider static electricity when designing, manufacturing and packaging electronic circuit boards.

WHAT YOU WILL NEED

- **A dry pen or comb**
- **Clean, dry hair or fur to rub the pen off**
- **A thin, slow and steady stream of water (from a tap or large bottle)**

HOW YOU CAN DO THIS

Rub the comb/pen through your hair rapidly several times. This works better on people with longer hair.

2. Slowly move the comb/pen towards the flow of water, as if you are about to touch it (but don't let it get wet!).
3. You should find that the water bends towards it! If it touches the water, the effect will disappear.
4. Hold the comb on the other side of the stream. It still bends toward the comb

WHAT ACTUALLY HAPPENED

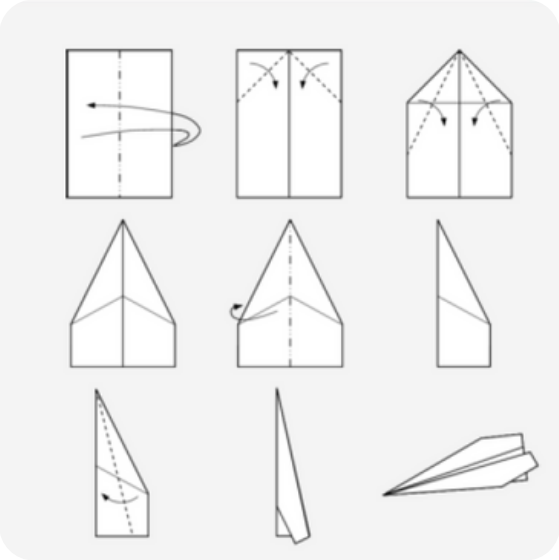
Most of the time positive and negative charges are balanced in an object, which makes that object neutral. When you brushed that comb through your hair electrons moved from your hair and collected on the comb. The comb then had an overall negative charge.

The molecules in the water stream are neutral – they have both positive and negative charges. Once the comb has a negative charge, it is attracted to things that have a positive charge. When the comb is moved closer to the water, it attracts the positively charged particles in the water and the water bends! If the water touches the comb, the electrons travel from the comb to the water and it neutralises the effect.

ENGINEER A PLANE

Your task: The Irish government have asked you, an engineer to design and prototype an airplane that will be used to fly/carry refugees to safety, these refugees have been stranded at sea for days and are very scared, they need your help!

Your plane should remain in the air for the furthest distance. How can your plane be improved to fly for longer, what features will your plane have?



WHAT YOU WILL NEED

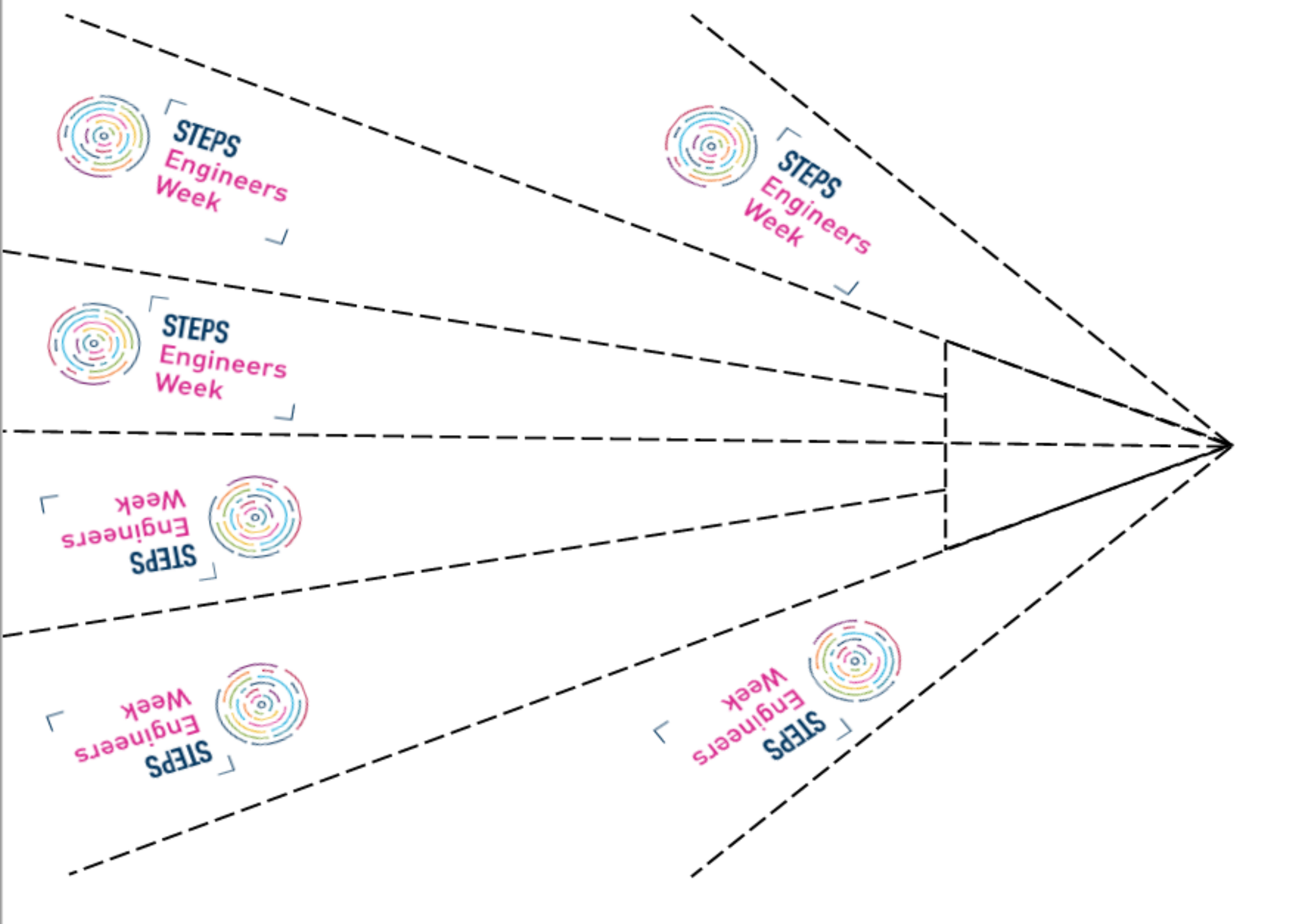
- **An A4 sheet of paper**
- **Measuring tape**

HOW YOU CAN DO THIS

There can be planes of various shapes made by folding the paper in different ways. Try and design a few shapes and see which flies the furthest. If you are having trouble, there are plenty of videos and instruction on the internet to help you. How far does your plane fly, what tweaks can be made

It's a balancing act! As with real airplanes there are 4 main forces, called aerodynamic forces, that enable a paper plane to stay in the air:

FORCE	DESCRIPTION
Thrust	When you throw the plan forward
Lift	Lift is a force that acts on the wings and helps the plane to move up. Big wings increase lift
Gravity	Gravity is the force that pulls the plane down. The right materials can create a lighter aircraft that stays up longer.
Drag (caused by the tail)	Drag is the opposite of thrust and it makes the plane slow down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